



SPECIES DIVERSITY OF THE NYMPHALIDAE (LEPIDOPTERA) NATURAL LANDSCAPES OF UZBEKISTAN

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Abstract

In this study, the species composition, distribution dynamics and population structure of butterflies belonging to the family Nymphalidae (Lepidoptera) were investigated across different natural landscapes. The research was carried out in forest, steppe and mountain landscapes of the Samarkand, Jizzakh and Tashkent regions. According to the results, a total of 46 species were recorded, 18 species in Samarkand, 27 species in Jizzakh and 31 species in the Tashkent region. The highest species diversity was observed in foothill and forest-steppe biotopes. The ecological conditions of the landscapes, climatic factors and plant cover had a direct influence on the number and seasonal fluctuations of Nymphalidae populations.

Keywords: Nymphalidae, Lepidoptera, biodiversity, population, landscape, Uzbekistan.

UZBEKISTONNING TABIIY LANDSHAFTLARIDA NYMPHALIDAE (LEPIDOPTERA) OILASI KAPALAKLARINING TURLAR XILMA-XILLIGI

Annotatsiya

Ushbu tadqiqotda Nymphalidae (Lepidoptera) oilasiga mansub kapalaklarning tur tarkibi, ularning turli tabiiy landshaftlarda tarqalish dinamikasi va populyatsiya tuzilishi o'rganildi. Tadqiqot Samarqand, Jizzax va Toshkent viloyatlarining o'rmon, dasht va tog' landshaftlarida olib borildi. Natijalarga



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ko‘ra, umumiy 46 tur qayd etildi, ulardan 18 tur Samarqand, 27 tur Jizzax, 31 tur Toshkent viloyatlarida uchradi. Eng yuqori turlar xilma-xilligi tog‘ oldi va o‘rmon-dasht biotoplarida kuzatildi. Landshaftlarning ekologik sharoitlari, iqlim omillari va o‘simlik qoplami Nymphalidae populyatsiyalarining soni va faol mavsumiy o‘zgarishlariga bevosita ta‘sir ko‘rsatdi.

Kalit so‘zlar: Nymphalidae, Lepidoptera, bioxilma-xillik, populyatsiya, landshaft, O‘zbekiston.

Introduction

Butterflies (Lepidoptera) are one of the most important groups of entomofauna, playing a major role in ecological systems as pollinators, food webs, and bioindicators. The family Nymphalidae is the largest and most ecologically diverse group within the order Lepidoptera. More than 6,000 species of this family have been described worldwide, and they are widespread on all continents, from the tropics to temperate and even subarctic regions (Tolman & Lewington, 2008). The ecological success of this family is explained by their morphological and physiological adaptability, especially the protective (cryptic) and signaling functions of wing colors (Brakefield et al., 1996). They belong to the large family Papilionoidea, which includes mainly medium- to large-sized, brightly colored species.

The most characteristic morphological feature of the Nymphalidae family is the reduced or rudimentary appearance of the front pair of legs. For this reason, they are also called “four-legged butterflies”. This feature distinguishes them as “brush-footed” butterflies (Scoble, 1992). In some species, the sensory hairs (setae) on these legs have been found to play an important role in olfaction and interspecific signaling (Opler & Krizek, 1984). The wing structure of adult butterflies also has a complex structure, which determines their movement, habitat and flight characteristics. The larvae of butterflies belonging to the Nymphalidae family are usually “spiny” or hairy, and the nymphs have metallic shiny spots (Ehrlich, 1958).



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The family Nymphalidae, first proposed as a scientific name by Rafinesque (1815), was initially described at the subfamily level under the name Nymphalia. Later, this term began to be applied to the entire family and is widely accepted in modern taxonomy (Ackery et al., 1999). Representatives of this family, in particular, species belonging to the genera *Vanessa*, *Nymphalis*, *Aglais*, *Argynnis* and *Maniola*, are a vivid example of ecological differentiation (ecotypic diversification).

Species of this family are found in mountain, forest, steppe and anthropogenic landscapes, depending on their habitats and ecological needs. Their distribution is significantly influenced by climate, humidity, food plants and biotic factors (DeVries, 1987). However, human activities, in particular the increased use of pesticides in agriculture, degradation of vegetation cover and urbanization processes, are leading to a decrease in the number of many species (Thomas, 2005).

Among them are such famous species as the monarch butterfly (*Danaus plexippus*), admiral (*Vanessa atalanta*), fritillaria (*Argynnis pandora*), and tortoiseshell butterflies (*Aglais urticae*, *Nymphalis polychloros*). Although most species have brightly colored forewings, their hindwings are dull or leaf-like, which allows them to protect themselves from danger.

Research on the species of the Nymphalidae family in Central Asia is limited and has been mainly conducted in a faunistic or morphological direction (Nazarov, 2015; Savchuk & Kuznetsov, 2021). Therefore, studying the distribution dynamics, population stability, and ecological adaptation characteristics of species belonging to this family in the Samarkand, Jizzakh, and Tashkent regions is an urgent scientific issue.

The territory of Uzbekistan, in particular the Samarkand, Jizzakh, and Tashkent regions, partially differs from each other in terms of relief, climate, and vegetation cover. Therefore, the study of the distribution dynamics and population structure of butterflies of the Nymphalidae family in these regions, as well as the analysis of their ecological adaptation mechanisms, is of great scientific and practical importance. This study aims to determine the species diversity, seasonal



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distribution and population stability of Nymphalidae butterflies in various natural landscapes of these three regions.

Research methodology. This study aimed to study the distribution dynamics and population structure of butterflies of the Nymphalidae (Lepidoptera) family found in various natural landscapes (forests, steppes, foothills and anthropogenic areas) of Samarkand, Jizzakh and Tashkent regions. The study was conducted on the basis of seasonal observations, field research and laboratory analyses during 2024–2025.

The research was carried out in the following main locations: in the Urgut (39°27'23.64"N 66°58'16.87"E) and Ishtikhon (39°57'06.38"N 66°22'10.45"E) districts of Samarkand region, with their foothill and forest-steppe regions. In the semi-desert landscapes around the Zamin mountain ranges (39°44'05.5"N 68°25'24.51"E) and Dashtabad (40°07'52"N 68°29'32.09"E) of Jizzakh region. In the mountainous and forest ecosystems of the Bostanlyk (41°42'05.18"N 70°08'24"E) district of Tashkent region (Figure 1). Natural conditions (climate, vegetation, relief, humidity) were recorded in each area and their impact on the distribution of butterflies of the Nymphalidae family was analyzed. The following standard entomological methods were used to collect and identify butterfly samples. Collection using entomological nets - 30-minute observations were made in an area of 100×100 m in each biotope. Pheromone and light traps were set to identify nocturnal species. Visual observations and counts were recorded during the daytime period, flight altitude, number and species diversity. Observations were carried out three times a month, from April to October. The Shannon-Wiener index and Simpson index were calculated for the number and frequency of occurrence of each species.

The formula for the Shannon-Wiener index is: $H' = -\sum_{i=1}^S p_i \ln(p_i)$

Where:

H' is the Shannon–Wiener (Shannon) diversity index;

S is the number of species;

p_i is the relative proportion of each species.



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The collected samples were studied in the laboratory for species identification. Studies on morphological characters of the species (Tshikolovets, 2011; Higgins & Riley, 1975; Tuzov, 2000) were identified using identifiers and allocated to the main subfamilies of the Nymphalidae family (Nymphalinae, Satyrinae, Danainae, Heliconiinae, etc.). If necessary, genital preparations were prepared and microscopic diagnostics were performed.

Analysis and results. During the study, 42 species of the Nymphalidae family were identified in various natural landscapes of Samarkand, Jizzakh and Tashkent regions, which were classified into 5 subfamilies: Nymphalinae, Satyrinae, Danainae, Heliconiinae and Apaturinae.

The number of species by region was distributed as follows (Table 1).

65% of the total species composition was found in all three regions, which indicates their ecological adaptability. However, some species, such as *Melanargia galathea* and *Hipparchia statilinus*, were found only in foothills and rocky biotopes.

The flight activity (phenology) of butterflies mainly fell on the months of April–October. The peak of activity was observed in June–July. The average number of individuals detected per month was as follows: in April 12.3 ± 1.5 individuals/100 m², in June 34.8 ± 2.1 individuals/100 m², in August 29.5 ± 1.7 individuals/100 m² and in September 17.6 ± 1.2 individuals/100 m². These data indicate that the number of species and population density are directly related to climatic conditions (temperature and humidity). During the warm and rich vegetation period (June–July), the population reached its maximum.

As a result of the analysis of population density, biotope diversity and plant resources were noted as the main factors in the distribution of Nymphalidae species. In this case, the Shannon index (H') was 2.98 in the forest-steppe zones, $H' = 2.34$ in semi-desert landscapes, and $H' = 3.12$ in the foothills. These values indicate a wider ecological stability and food base in mountainous areas. Also, the Pearson correlation ($r = 0.82$) showed a positive relationship between the number of species and plant species diversity.



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The similarity of the species composition according to the Jaccard similarity index was assessed as follows: Samarkand–Jizzakh: 0.73, Samarkand–Tashkent: 0.68, Jizzakh–Tashkent: 0.64.

As a result of cluster analysis (Ward's method), three main groups were formed: Forest and mountain biotope group *Vanessa cardui*, *Aglais io*, *Danaus chrysippus*; Steppe and semi-desert biotope group *Melanargia galathea*, *Coenonympha pamphilus*; Anthropogenic areas group *Pararge aegeria*, *Junonia orithya*.

During the study, phenological shifts were observed in some species. For example, *Vanessa atalanta* and *Aglais urticae* species entered the spring flight phase 10–15 days earlier than usual. These changes were assessed as an adaptive response to climate warming.

The results of the study show that butterflies of the Nymphalidae family are highly ecologically adaptable, but their distribution is closely related to microclimate, vegetation cover and human activity. Some species (for example, *Danaus chrysippus*, *Vanessa cardui*) also successfully live in anthropogenic areas, which indicates their ecological plasticity.

The results of the study show that the distribution, number and diversity of butterflies of the Nymphalidae (Lepidoptera) family differ significantly in different natural landscapes. Their population dynamics are closely related to climatic conditions, vegetation cover, diversity of microhabitats and the level of human activity. As for the influence of ecological factors, the differences in the number of species and population density determined as a result of observations in the Samarkand, Jizzakh and Tashkent regions were distributed in accordance with the ecological zones. A high diversity of Nymphalidae species was observed in the mountainous and forest-steppe zones (in particular, in the Bostanlyk and Urgut regions). This is explained by the richness of plant species and the stability of the microclimate. These results are consistent with the studies conducted in Central Asia by Tshikolovets (2011) and Tuzov (2000), who also noted that butterfly diversity directly depends on the richness of the biotope.

Observations of seasonal changes in population dynamics revealed that the activity of Nymphalidae species is highest in June–July. This period is associated



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with the abundance of flowering plants and nectar sources. Observations conducted in Europe by Pollard & Yates (1993) also noted this period as the most active phase of Nymphalidae species. In the semi-desert landscapes of Jizzakh region, a sharp decrease in the number of butterflies was noted due to high temperatures and sparse vegetation cover, which indicates the impact of environmental stress factors.

According to the similarity of species and the state of adaptation to the biotope, the results of the Jaccard similarity index (0.64–0.73) indicate the presence of common ecological bases in the biotopes of the three regions. Nevertheless, some species were found only in certain landscape types. For example, *Melanargia galathea* and *Hipparchia statilinus* were observed only on rocky and mountain slopes, which reflects their stenotopic (narrowly adapted) characteristics. In contrast, *Vanessa cardui* and *Danaus chrysippus*, as eurytopic species with a wide ecological range, were observed to successfully live not only in natural, but also in anthropogenic areas. Such species indicate a high level of ecological plasticity of the Nymphalidae family.

The results of this study confirm that climate, landscape type, plant diversity and anthropogenic pressure play a key role in the distribution of Nymphalidae species. The high number of species identified in Samarkand and Tashkent regions allows us to designate these regions as centers of biodiversity. In Jizzakh region, the aridity of the climate and the limited number of plant species were assessed as factors reducing species richness.

Conclusions and recommendations. The results of the study showed that representatives of the Nymphalidae (Lepidoptera) family are widely distributed in the central (Jizzakh), western (Samarkand) and eastern (Tashkent) regions of Uzbekistan, adapting to ecological and biogeographical conditions.

The following main scientific conclusions were obtained, including that during the study on total diversity, a total of 42 species were identified, 65% of which were found in all three regions, indicating the presence of species with a high level of ecological plasticity. Ecological differences The highest species diversity was recorded in mountainous and forest-steppe biotopes ($H' = 3.12$), while this



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indicator was lower in semi-desert and anthropogenic areas ($H' = 2.34$). Seasonal dynamics The active flight period of butterflies mainly fell on the period from April to October, and the peak period of population density was observed in June–July. Phenological shifts were mainly attributed to the early flight phase of species such as *Vanessa atalanta* and *Aglais urticae* as a direct effect of climate warming.

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